[REPORT OF THE SECRETARY OF THE NAVY, 1892. pp. 133-140.]

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OF

THE SUPERINTENDENT

OF THE

U. S. NAVAL OBSERVATORY

FOR THE

YEAR ENDING 1892 JUNE 30

WASHINGTON
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U. S. NAVAL OBSERVATORY,
Washington, September 29, 1892.

SIR: I have the honor to present the subjoined report, called for by the Bureau's order dated August 2, 1892 (No. 3243), of the operations of the Naval Observatory during the year ending June 30, 1892.

The personnel of the establishment on July 1, 1891, consisted of the following officers:

Capt. F. V. McNair, superintendent; Lieut. Commander Walton Goodwin; Ensigns Thomas Snowden, J. A. Hoogewerff, H. H. Whittlesey; Profs. Asaph Hall, Wm. Harkness, J. R. Eastman, Edgar Frisby, and S. J. Brown. Changes have occurred as follows—reported for duty: Passed Assistant Engineer A. V. Zane, on July 17, 1891; Commander Joshua Bishop, August 5, 1891; Ensign W. W. Gilmer, August 8, 1891. Detachments: Ensign H. H. Whittlesey, on August 12, 1891; Ensign W. W. Gilmer, August 19, 1891; Ensign Thomas Snowden, April 16, 1892; Ensign J. A. Hoogewerff, June 25, 1892.

THE 26-INCH EQUATORIAL.

On October 15, 1891, Prof. Asaph Hall was retired for age, and the Observatory lost the services of one of the most illustrious astronomers of the present century. His discovery of the satellites of Mars brought renown not only to himself, but also to the naval service and to the country, and his magnificent series of measurements of double stars is comparable both in extent and accuracy with the best existing observations of the same character. Since October 15, 1891, the observer was Assistant Astronomer Asaph Hall, jr. Prof. Hall was engaged in completing his observations of double stars and in reducing and collecting them into a catalogue, which has been published by the Observatory as Appendix I to the volume for 1888. He also made observations for the flexure and position of the telescope and investigated anew the periodic errors of its micrometer screw.

Assistant Astronomer Hall was engaged in observing the satellite of Neptune, the satellites of Saturn, and the two outer satellites of Uranus. The reduction of all these observations is well advanced, and those of Neptune's satellite have been published in Gould's Astronomical Journal. They confirm the motion of the orbit plane of the satellite with respect to the orbit of Neptune which was suspected by Marth in 1886.

As Mars will be nearer the Earth during its opposition in August, 1892, than at any other time since the discovery of its satellites in 1877, it seemed fitting that Prof. Hall, the discoverer of these satellites, should have the privilege of observing them once more under such exceptionally favorable circumstances. Accordingly, the Superintendent has tendered him the use of the 26-inch telescope for that purpose, and it is expected that an excellent series of measures will be secured. This telescope will be dismounted immediately after the completion of the observations of the Mars satellites in September, and meanwhile a new and more modern mounting is being constructed for it by Messrs. Warner & Swasey, of Cleveland, Ohio. The micrometer and circles are to be illuminated by incandescent lights; a larger position circle is to be provided, and a more powerful driving clock is to take the place

of the present one. Furthermore, the large dome at the new site is to have an elevating floor to facilitate the use of spectroscopes and other heavy apparatus. By means of these additions and improvements, there will be a gain in convenience of observation and in the amount of work accomplished.

THE TRANSIT CIRCLE.

(Prof. J. R. Eastman in charge.)

Since the annual report for 1891 the transit circle has been altered and repaired, and installed in the new observing house, which unfortunately was not finished in time to make the proposed observations of Mars. The instrument will probably be ready for use in October, 1892. The present force for transit circle work consists only of the officer in charge and two computers. The reduction of the work for 1889 is ready for the printer, and the reductions for 1890 and 1891 are nearly completed. At present, a part of the force is engaged in making a card catalogue of the stars contained in the Washington zones.

THE 9.6-INCH EQUATORIAL.

(Professor Edgar Frisby in charge.)

This instrument has been used in observing asteroids, occultations of stars by the moon, and comets, at every favorable opportunity. The observations have all been reduced, and most of the results have been published in the astronomical journals. Two nights in each week have been set apart for the accommodation of visitors.

CHRONOMETERS.

(Assistant Astronomer A. N. Skinner in charge.)

Mr. Skinner assumed charge April 26, 1892. He was assisted by Computer F. E. Dennett.

During the year 44 chronometers have been issued and 40 turned in. Forty-two standard and 13 hack chronometers are ready for issue; 5 await trial. There are in use on naval vessels 119 standard and 36 hack chronometers; at Mare Island Navy-yard, 29 standard and 14 hack chronometers; at other shore stations, 13 standard and 19 hack chronometers; surveyed and condemned 14, in museum 17, and at the makers for repairs, 44 chronometers. Pocket chronometers ready for issue, 5; in use at shore stations, 1; comparing watches ready for issue, 17.

Twenty-nine chronometers received from makers, cleaned and repaired, were on trial from January 9 to July 11, 1892. The records of this trial are given in Appendix A.

TIME SERVICE.

Owing to the detachment from duty at the Observatory of the officers connected with the time service, it was, on August 1, placed in charge of Prof. S. J. Brown, and on September 1 Computer George A. Hill was detailed as his assistant. No other changes have been made in this service.

MERIDIAN TRANSIT INSTRUMENT.

The transit instrument has been constantly in use for determination of clock corrections in connection with the time service. Ensign Thomas Snowden was in charge until August 1, 1891, when it was necessary to place this instrument and the time service in charge of Prof. S. J. Brown, owing to the detachment of the officers engaged in this and the chronometer work. Computer Hill was his assistant.

MAGNETIC INSTRUMENTS.

The usual routine observations and reductions have been kept up during the year. The observations and reductions for 1891 were published as an appendix to the Washington Observations for 1888.

Ensign J. A. Hoogewerff was in charge until November 1, 1891, when, owing to notification by the Department that his services would be required elsewhere, he was relieved by Prof. S. J. Brown. The work was carried on conjointly by them until June 25, when Ensign Hoogewerff was detached.

LIBRARY AND PUBLICATIONS.

The library, printing, and distribution of the Observatory publications have been under the general supervision of Assistant Astronomer H. M. Paul, with William D. Horigan assistant librarian.

During the fiscal year 1891–'92 bound volumes only have been entered in the accession book. These number 299 (125 by exchange and 174 by purchase), making the total number of bound volumes in the library about 13,500. The annual accessions of unbound books, periodicals, and pamphlets amount to about 400 volumes. One hundred and sixty volumes have been bound during the year, leaving upwards of 1,000 volumes still unbound owing to want of funds.

The following publications have been distributed to the regular exchange lists:

1. The Annual Report of the Superintendent for 1891.
2. The Washington Observations for the year 1887.
3. The Washington Observations for the year 1888.
4. 1887: Appendix 1—Marsh, C. C. Magnetic Observatories of Europe.
5. 1887: Appendix 2—Hoogewerff, J. A. Magnetic Observations, 1890.
6. 1887: Appendix 3—Eastman, J. R. Meteorological Observations, 1883–'87.
7. 1888: Appendix 1—Hall, Asaph. Double-star Observations. Part 2, 1880–'91.
8. 1888: Appendix 2—Hoogewerff, J. A. Magnetic Observations, 1891.
9. 1888: pp. D. 1–60—Meteorological Observations, 1888.

TOTAL SOLAR ECLIPSE OF APRIL 15, 1893.

A total solar eclipse will occur on April 15, 1893, under circumstances so favorable that its observation is very desirable. The central line of the shadow sweeps across South America, the Atlantic Ocean, and the northwestern part of Africa. The duration of totality is 4 minutes and 42 seconds near Ceara, on the northern coast of Brazil, and 4 minutes and 10 seconds near Bathurst, Senegambia, in West Africa. It is important that this opportunity for studying the constitution of the sun should be utilized by sending two observing parties, one to Ceara, Brazil, and the other to Bathurst, West Africa.

It is recommended that expeditions be sent to those places composed entirely of officers and others under the control of the Navy Department. Independent of travel and transportation, the sum of $5,000 will

be necessary for the purchase of instruments, outfit and contingent expenses. Such appropriation must be made available prior to January 15, 1893, to accomplish the desired observations.

NEW NAVAL OBSERVATORY.

On September 8, 1891, the contract for the construction of the new Naval Observatory was declared forfeited. On February 16, 1892, a contract was awarded for the completion of the new Naval Observatory; which contract has not been fulfilled.

The installation of boilers, engines, electric plant, stand-pipe and water-supply system will shortly be completed.

The grounds have been graded and roads constructed to the extent that the appropriation for that purpose admitted.

The Superintendent's residence is still in the hands of the contractor.

Very respectfully,

F. V. McNAIR,
Captain, U. S. Navy, Superintendent.

The CHIEF OF THE BUREAU OF EQUIPMENT,
Navy Department.

Estimates of appropriations required for the service of the fiscal year ending June 30, 1894, by the United States Naval Observatory.

Detailed objects of expenditure and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year ending June 30, 1893.
SALARIES, NAVAL OBSERVATORY			
One assistant astronomer (R. S., p. 27, sec. 167; Aug, 5, 1882, vol. 22, p. 245, sec. 1, July 16, 1892).	$2,000.00		
Two assistant astronomers, at $1,800 each (same acts)	3,600.00		
One clerk of class four (same acts)	1,800.00		
One instrument-maker (same acts)	1,500.00		
One electrician (same acts)	1,500.00		
One photographer (same acts)	1,200.00		
Five computers, at $1,200 each (same acts)	6,000.00		
One assistant librarian (same acts)	1,200.00		
One copyist (same acts)	900.00		
One carpenter (same acts)	1,000.00		
One engineer (same acts)	1,000.00		
Two assistant engineers, at $900 each (submitted)	1,800.00		
Two skilled laborers, one at $1,000 and one at $720 (same acts).	1,720.00		
Three firemen, at $720 each (same acts; increase of one submitted)	2,160.00		
Six watchmen, at $720 each (same acts)	4,320.00		
Two assistant messengers, at $720 each (submitted)	1,440.00		
One elevator conductor (submitted)	720.00		
Eleven laborers, at $660 each (same acts)	7,260.00		
Two charwomen, at $240 each (submitted)	480.00		
		41,600.00	36,440.00
NOTE.—Assistant engineers and firemen. Work at the Naval Observatory is carried on at night in addition to the regular office hours. There are two boilers for heating purposes, and one boiler, two engines, and two dynamos, which, together with the extensive system of lighting, heating, and water works, require three engineers and three firemen for the 24 hours, each engineer and fireman being on duty eight hours.			
Assistant messengers.—One assistant messenger to Superintendent and one for mail-carrier. All mail for the Observatory is delivered at the Navy Department, which is distant from the Observatory about 2½ miles via Tennallytown road.			
Elevator conductor.—The number of visitors to the Naval Observatory at night is about 2,500 per annum, the majority of whom are women, and an expert elevator conductor is essential to prevent accident.			

Estimates of appropriations required for the service of the fiscal year ending June 30, 1894, by the United States Naval Observatory—Continued.

Detailed object of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year ending June 30, 1893.
CONTINGENT AND MISCELLANEOUS EXPENSES.			
Miscellaneous computations. (August 5, 1882; July 16, 1892, 22 Stat. L., p. 245, sec. 1.)	$1,200.00		
Professional and scientific books, periodicals, engravings, photographs, fixtures, and supplies for the library. (Same acts.)	1,000.00		
Apparatus and instruments, and repairs of the same. (Same acts.)	2,500.00		
Repairs to buildings, fixtures, and fences; furniture, gas, chemicals, and stationery; freight (including transmission of public documents through the Smithsonian exchange), foreign postage and expressage; plants, fertilizers, and all contingent expenses (increase of $2,050 submitted to equal the amount approved March 3, 1891, for 1891–'92). (Same acts.)	4,550.00		
Fuel, oil, grease, tools, pipe, wire, and other materials needed for the maintenance and repairs of boilers, engines, heating apparatus, electric lighting and power plant, and water-supply system; purchase and maintenance of teams; material for boxing nautical instruments for transportation; paints, telegraph and telephone service, and incidental labor. (Same acts.)	7,500.00		
		$16,750.00	$14,700 00
NOTE.—*Repairs and all contingent expenses.*—The amount asked for ($4,550) is the same appropriated for the year 1892. The amount granted for 1893 is inadequate to meet all the unforeseen contingencies occurring in connection with the occupation of a new establishment incomplete in minor details.			
Public works under Navy Department.			
GROUNDS AND ROADS—NEW NAVAL OBSERVATORY.			
For continuing grading, extending roads and paths, clearing grounds of new Naval Observatory, and filling ravine contiguous to boiler house. (Submitted.)	12,000.00		
		12,000.00	
NOTE.—The new Observatory grounds contain 70 acres of land, much of which is rough, wooded with wild undergrowth and intersected by ravines. The heavy grading, filling, curbing, and roads have been completed in the immediate vicinity of the main building. The ravine behind the boiler house requires immediate filling to prevent the foundations of the building being undermined and washed out in heavy rains. The system of roadways and paths to connect the various buildings has been commenced.			
NEW BUILDINGS.			
For three dwellings for observers, at $10,000 each. (Submitted.)	30,000.00		
		30,000.00	
NOTE.—In order that the work of a large observatory may be properly and economically done, it is absolutely necessary that the observers be within prompt call to their instruments throughout day and night. Very important observations can often be secured from the clearing of the sky for a few hours, or even in some cases for a few minutes, if the observer be within easy call by the watchman. This can only be accomplished, in the isolated situation of the new Observatory, by having dwellings upon the grounds for the observers. The Government erects dwellings at all its navy-yards, arsenals, forts, and schools for the officers on duty there. But no service requires such unremitting attention and constant presence at all hours as that of the astronomer, and no observatory can be regarded as economically managed which does not furnish dwellings for all its observers close by their instruments. It is estimated that with the observers living on the grounds of the new Observatory, not only will two or three times as much work be done as it will be possible to do otherwise, but the quality of this delicate work will be materially improved on account of the observers being in a proper physical condition to begin their labors, instead of with nerves unstrung from hurrying some miles from their homes immediately after meals, or at unreasonable hours of the night.			

Estimates of appropriations required for the service of the fiscal year ending June 30, 1894, by the United States Naval Observatory—Continued.

Detailed object of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year ending June 30, 1893.
STATIONARY FIRE ENGINE.			
For 1 stationary fire engine, with pipes, connections and frame shelter. (Submitted.)	$4,500.00	$4,500.00	
NOTE.—The capacity of the present pumping-engines and stand pipe is not adequate for the extinction of any extensive fire. It is proposed, therefore, to utilize the pond in the Industrial Home grounds, adjoining the Observatory grounds, as a reserve.			

Record of trial of repaired chronometers, January 9 to July 11, 1892.

[In temperature room from January 9 to March 12; after that in chronometer room.]

Relative number.	Repaired by—	Time, 1892		Jan. 9 to Jan. 14.	Jan. 15 to Jan. 20.	Jan. 21 to Jan. 26	Feb. 5 to Feb. 10	Feb. 11 to Feb. 16.	Feb. 17 to Feb. 22.	Feb. 23 to Feb. 28.	Mar. 1 to Mar. 6.	Mar. 7 to Mar. 12.	Mar. 13 to Mar. 23.	Mar. 23 to Apr. 2.	Apr. 2 to Apr. 12.	Apr. 12 to Apr. 22.
		Temperature		44°.67	55°.12	70°.13	84°.80	90°.10	85.°23	69°.80	54°.74	45°.35	56°.81	62°.52	69°.51	63°.25
		Relative humidity, per cent.		69.97	67.76	70.60	66.89	68.12	70.81	70.76	67.88	73.44	.....	.....	.....	.....
		Chronometer-maker.	*No.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*
1	Neg...	John Hutton	372	+1.508	+0.446	—0.036	+0.740	+1.478	+1.058	+0.404	+0.686	+1.872	+0.572	+0.093	—0.218	—0.168
2	Neg...	T. S. & J. D. Negus	1596	+1.428	+0.496	+0.214	+1.040	+1.378	+1.058	+0.104	+0.586	+1.772	+0.897	+0.668	+0.556	+0.482
3	Neg...	....do	1036	+1.308	+0.196	—0.786	—0.110	+0.178	—0.192	—0.346	+0.386	+1.572	—0.078	—0.757	—1.019	—0.868
4	Bl	John Bliss & Co	2827	+0.558	+1.196	+1.764	+1.290	+1.278	+1.508	+2.004	+1.536	+0.722	+1.647	+1.568	+1.506	+1.557
5	Neg...	T. S. & J. D. Negus	1195	+2.058	+0.596	—0.336	—0.110	+0.328	+0.408	+0.054	+0.686	+2.022	+0.847	—0.007	—0.369	—0.118
6	Neg...	....do	1317	+2.008	+1.196	+0.364	+0.540	+1.278	+0.908	+0.154	+0.936	+2.072	+1.547	+0.668	+0.356	+0.232
7	Neg...	....do	1300	+2.158	+0.796	+0.064	+0.290	+1.028	+1.108	+0.454	+1.236	+2.072	+1.022	+0.268	—0.094	—0.218
8	Bd	Wm. Bond & Son	520	+3.258	+2.396	+2.064	+3.290	+3.978	+3.758	+2.754	+2.486	+3.372	+2.697	+2.543	+2.681	+2.557
9	Neg...	T. S. & J. D. Negus	1097	+0.608	—0.754	—1.986	—1.260	—0.672	—0.992	—1.546	—0.914	+0.172	—1.078	—1.507	—1.969	—1.718
10	Neg...	T. S. & J. D. Negus, S. B. C.	1536	+0.616	—0,346	—0.581	+0.697	+1.523	+1.064	+0.060	+0.291	+0.927	+0.276	—0.102	—0.091	—0.087
11	Neg...	....do	1520	—0.564	—1.676	—1.931	—0.623	+0.283	—0.186	—1.290	—1.159	—0.473	—1.074	—1.402	—1.390	—1.405
12	Neg...	T. S. & J. D. Negus	1244	+1.458	+0.296	—0.536	+0.790	+1.278	+0.658	+0.204	+0.686	+1.472	+0.697	+0.118	+0.056	+0.132
13	Neg...	....do	1298	+0.358	—0.804	—1.186	—0.110	+0.378	+0.008	—0.396	—0.164	+1.122	—0.853	—1.557	—1.869	—1.768
14	Neg...	....do	919	—0.192	—1.404	—2.536	—2.160	—1.322	—1.592	—2.446	—1.814	—0.678	—1.478	—2.207	—2.519	—2.443
15	Neg...	....do	1343	—0.542	—1.804	—2.386	—1.660	—0.822	—0.792	—1.346	—1.214	—0.028	—1.153	—1.507	—1.644	—1.618
16	Neg...	....do	1059	+0.158	—0.754	—0.636	+0.490	+1.178	+0.858	—0.346	—0.464	+0.572	—0.528	—0.757	—0.769	—0.993
17	Neg...	T. S. & J. D. Negus, S. B. C.	1518	+0.536	—0.096	+0.099	+1.047	+2.063	+1.934	+0.360	+0.241	+0.727	—0.674	—0.702	—0.415	—0.588
18	Neg...	T. S. & J. D. Negus	1521	+3.208	+1.496	+0.364	+0.490	+1.028	+0.908	+0.704	+1.786	+3.372	+1.722	+0.968	+0.581	+0.782
19	Bd	Wm. Bond & Son	505	+2.608	+1.046	—0.186	+0.440	+0.878	+0.908	+0.804	+1.736	+2.822	+1.597	+0.793	+0.306	+0.632
20	Neg...	T. S. & J. D. Negus	1267	+0.808	—1.054	—1.936	—0.360	+0.428	—0.042	—0.946	—0.764	+0.472	—0.578	—1.382	—1.844	—1.743
21	Neg...	T. S. & J. D. Negus, S. B. C.	1539	+4.986	+4.374	+3.369	+4.067	+4.433	+3.864	+3.410	+4.391	+4.477	+3.651	+3.423	+3.460	+3.488
22	Neg...	T. S. & J. D. Negus	1328	+2.508	+1.196	+0.264	+0.740	+2.078	+1.708	+0.154	+1.386	+2.722	+1.097	+0.643	+0.481	+0.257
23	Bd	Wm. Bond & Son	272	—1.592	—0.954	+0.314	+1.590	+2.578	+1.958	+0.704	—0.664	—0.878	—0.928	—0.382	+0.506	—0.343
24	Neg...	T. S. & J. D. Negus	1308	+1.758	+0.946	+0.164	—0.310	+1.028	+1.508	+1.004	+1.686	+2.972	+0.972	+0.443	+0.456	+0.532
25	Neg...	T. S. & J. D. Negus, S. B. C.	1519	+1.016	—0.646	—0.181	+0.697	+1.583	+1.704	+0.410	—0.059	+1.227	+0.201	—0.227	—0.190	—0.087
26	Neg...	T. S. & J. D. Negus	1268	+1.908	+0.146	—1.486	—0.210	+0.478	+0.058	+0.054	+1.036	+2.172	+0.847	—0.382	—0.794	—0.543
27	Neg...	T. S. & J. D. Negus, S. B. C.	1527	+1.016	+0.574	+1.869	+3.397	+4.483	+4.064	+2.230	+1.241	+2.507	+2.101	+2.098	+2.185	+1.664
28	Neg...	T. S. & J. D. Negus	1126	+1.008	—0.004	+0.314	+0.740	+1.128	+1.008	+0.554	+1.036	+3.622	+1.897	+0.293	+0.306	+0.207
29	Neg...	T. S. & J. D. Negus, M. T. B. C.	1255	—0.142	—1.504	—0.536	+0.590	+2.028	+1.508	+0.154	+0.486	+1.872	+0.447	—0.032	+0.206	—0.268

NOTE.—The sign + signifies a losing rate; — signifies a gaining rate. S. B. C. signifies sideral break circuit; M. T. B. C., mean time break circuit.

Record of trial of repaired chronometers, January 9 to July 11, 1892.

[In temperature room from January 9 to March 12; after that in chronometer room.]

Relative number.	Repaired by.	Time, 1892		Apr. 22 to May 2.	May 2 to May 12.	May 12 to May 22.	May 22 to June 1.	June 1 to June 11.	June 11 to June 21.	June 21 to July 1.	July 1 to July 11.	Temperature of compensation.	Temperature constant.	First trial number.	Final trial number.
		Temperature		67°.70	74°.77	72°.76	69°.92	78°.34	81°.32	82°.49	76°.79				
		Relative humidity, per cent.													
		Chronometer-maker.	*No.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	°			
1	Neg...	John Hutton	372	−0.369	−0.132	−0.355	−0.344	+0.142	+0.218	+0.350	−0.021	67.69	+0.00242	10.062	11.526
2	Neg...	T. S. & J. D. Negus	1596	+0.482	+0.543	+0.195	+0.356	+0.717	+0.543	+0.625	+0.098	66.97	+0.00281	10.421	12.854
3	Neg...	do	1036	−1.018	−0.982	−1.030	−1.069	−0.683	−0.732	−0.600	−0.827	72.59	+0.00281	12.536	13.392
4	Bl....	John Bliss & Co	2827	+1.482	+1.293	+1.170	+1.031	+1.467	+1.093	+1.200	+0.748	70.22	−0.00222	8.356	14.961
5	Neg...	T. S. & J. D. Negus	1195	−0.193	−0.407	−0.580	−0.644	−0.533	−0.807	−0.625	−0.602	73.43	+0.00237	12.102	16.387
6	Neg...	do	1317	+0.107	−0.157	−0.330	−0.144	+0.092	+0.268	+0.575	+0.123	72.00	+0.00281	12.613	17.378
7	Neg...	do	1300	−0.418	−0.232	−0.280	−0.144	+0.142	+0.018	0.000	−0.052	71.97	+0.00264	15.686	18.230
8	Bd....	Wm. Bond & Son	520	+2.532	+2.693	+2.420	+2.056	+3.142	+3.093	+3.325	+2.973	62.87	+0.00250	15.305	18.690
9	Neg...	T. S. & J. D. Negus	1097	−1.993	−2.232	−2.305	−2.244	−2.308	−2.382	−2.250	−2.577	71.37	+0.00347	16.984	19.015
10	Neg...	T. S. & J. D. Negus, S. B. C.	1536	−0.186	+0.075	−0.108	−0.135	+0.376	+0.553	+0.785	+0.381	64.99	+0.00303	19.438	20.001
11	Neg...	do	1520	−1.494	−1.199	−1.383	−1.511	−1.141	−0.848	−0.464	−1.070	64.51	+0.00309	19.264	20.166
12	Neg...	T. S. & J. D. Negus	1244	−0.043	+0.043	−0.155	−0.269	−0.008	−0.132	−0.125	−0.352	68.84	+0.00342	17.644	20.518
13	Neg...	do	1298	−1.868	−1.657	−1.880	−1.944	−1.383	−1.182	−1.000	−1.477	66.86	+0.00231	17.314	20.867
14	Neg...	do	919	−2.743	−2.782	−2.955	−3.044	−2.958	−3.207	−3.075	−3.477	71.32	+0.00331	17.135	21.953
15	Neg...	do	1345	−1.593	−1.257	−1.355	−1.469	−0.958	−0.657	−0.550	−0.777	67.84	+0.00220	22.524	24.149
16	Neg...	do	1059	−1.318	−1.182	−1.555	−1.994	−1.658	−1.732	−1.600	−2.227	60.75	+0.00232	15.162	25.338
17	Neg...	T. S. & J. D. Negus, S. B. C.	1518	−0.711	−0.175	−0.533	−0.710	−0.634	+0.578	+1.110	+0.381	60.28	+0.00243	17.091	26.646
18	Neg...	T. S. & J. D. Negus	1521	+0.582	+0.418	+0.195	+0.256	+0.342	+0.368	+0.500	+0.223	75.54	+0.00281	26.355	27.416
19	Bd....	Wm. Bond & Son	505	+0.307	+0.193	+0.145	+0.106	+0.167	+0.118	+0.300	+0.023	73.70	+0.00320	25.791	27.450
20	Neg...	T. S. & J. D. Negus	1267	−2.018	−1.757	−1.855	−1.919	−1.208	−0.982	−0.550	−0.877	66.97	+0.00391	25.685	29.725
21	Neg...	T. S. & J. D. Negus, S. B. C.	1539	+3.113	+3.300	+2.942	+2.815	+3.451	+3.528	+3.810	+3.531	71.97	+0.00346	28.167	31.142
22	Neg...	T. S. & J. D. Negus	1328	+0.332	+0.593	+0.245	+0.256	+0.917	+0.968	+1.075	+0.623	70.22	+0.00463	31.799	33.830
23	Bd....	Wm. Bond & Son	272	+0.232	+0.793	+0.620	+0.356	+1.267	+1.393	+1.500	+0.823	19.62	−0.00012	37.676	38.560
24	Neg...	T. S. & J. D. Negus	1308	+0.482	+0.643	+0.370	+0.356	+0.742	+0.618	+0.750	+0.398	77.19	+0.00165	42.547	44.996
25	Neg...	T. S. & J. D. Negus, S. B. C.	1519	−0.037	+0.225	−0.357	−0.186	+0.201	+0.128	+0.160	+0.081	51.10	+0.00137	40.045	46.320
26	Neg...	T. S. & J. D. Negus	1268	−1.068	−1.107	−1.180	−1.194	−1.358	−1.132	−0.600	−0.827	72.55	+0.00430	46.510	52.391
27	Neg...	T. S. & J. D. Negus, S. B. C.	1527	+1.637	+2.151	+1.792	+1.565	+2.051	+1.928	+2.010	+1.280	30.31	+0.00118	44.119	56.651
28	Neg...	T. S. & J. D. Negus	1126	+0.057	+0.168	+0.045	+0.056	+0.492	+0.618	+0.900	+0.623	64.81	+0.00115	47.924	71.934
29	Neg..	T. S. & J. D. Negus, M. T. B. C	1255	−0.143	+0.643	+0.295	+0.006	+0.642	+0.843	+1.050	−0.227	57.24	+0.00203	68.396	76.604

NOTE.—The sign + signifies a losing rate; — signifies a gaining rate. S. B. C. signifies sideral break circuit; M. T. B. C., mean time break circuit.